DMSO

DoD High Level Architecture for Modeling and Simulation

Dr. Judith Dahmann
Chief Scientist
Defense Modeling & Simulation Office
(703) 998-0660 fax (703) 998-0667
jdahmann@dmso.mil

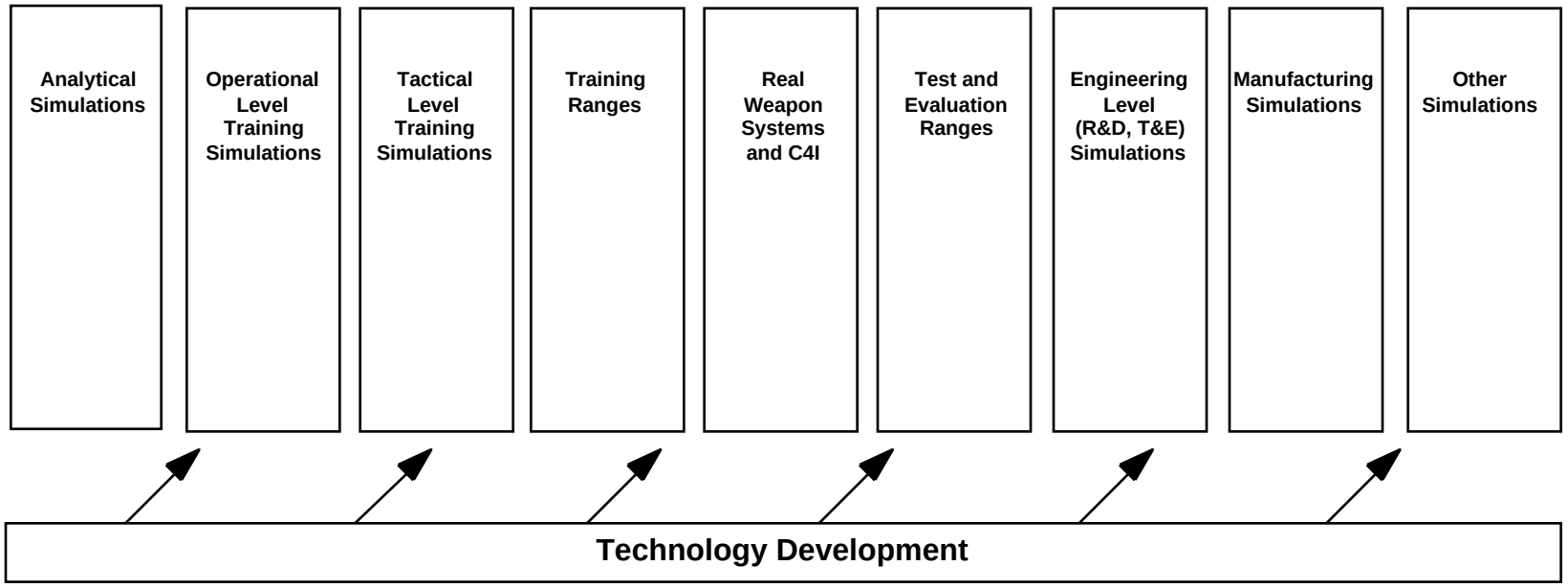
An Overarching Technical Framework

DMSO

Master Plan's Technical Framework

High Level Architecture, Conceptual Models Of the Mission Space, Data Standardization

Domain-specific aspects



DoD M&S Master Plan Objective 1-1

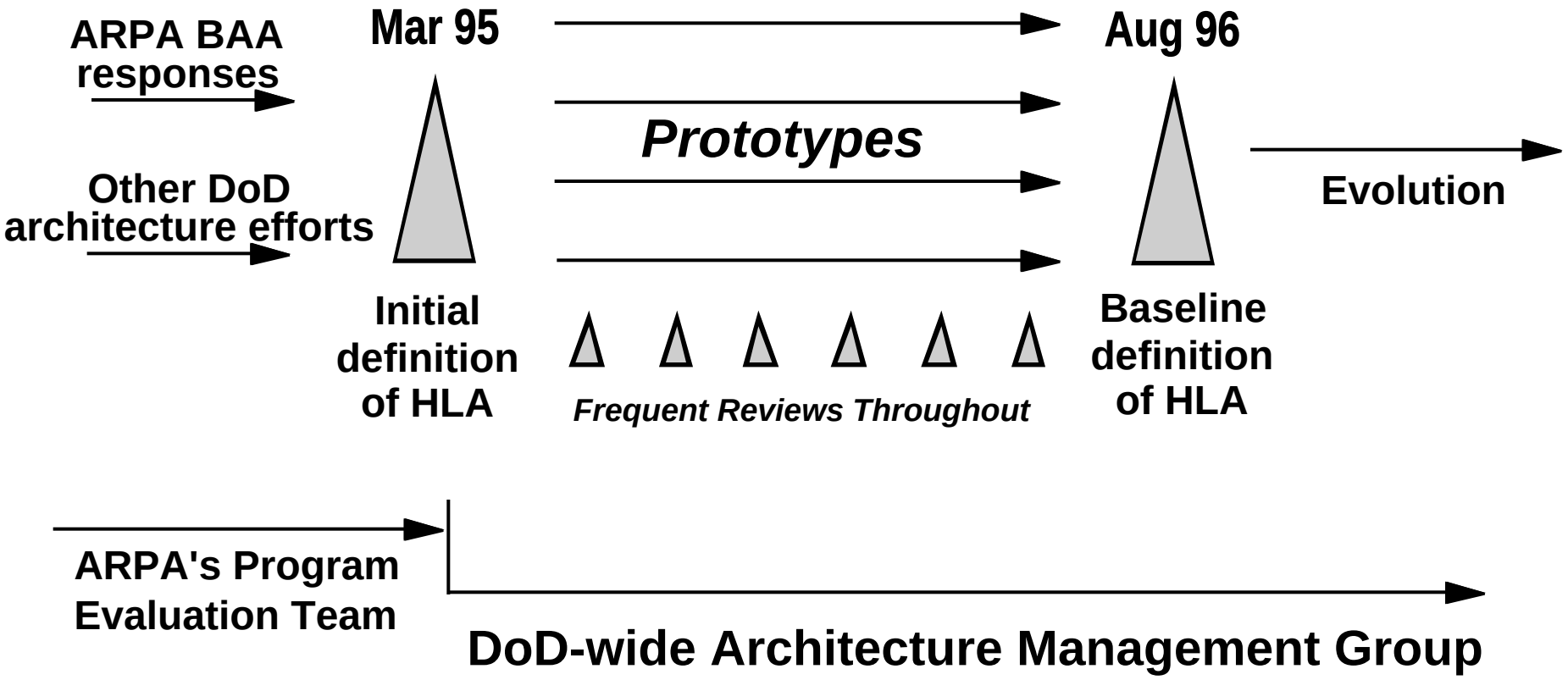
DMSO

- **Objective 1-1. Establish a common high-level simulation architecture to facilitate the interoperability of all types of models and simulations among themselves and with C4I systems, as well as to facilitate the reuse of M&S components.**
  - **Simulations developed for particular DoD Components or Functional Areas must conform to the High Level Architecture**
  - **Further definition and detailed implementation of specific simulation system architectures remain the responsibility of the developing Component**

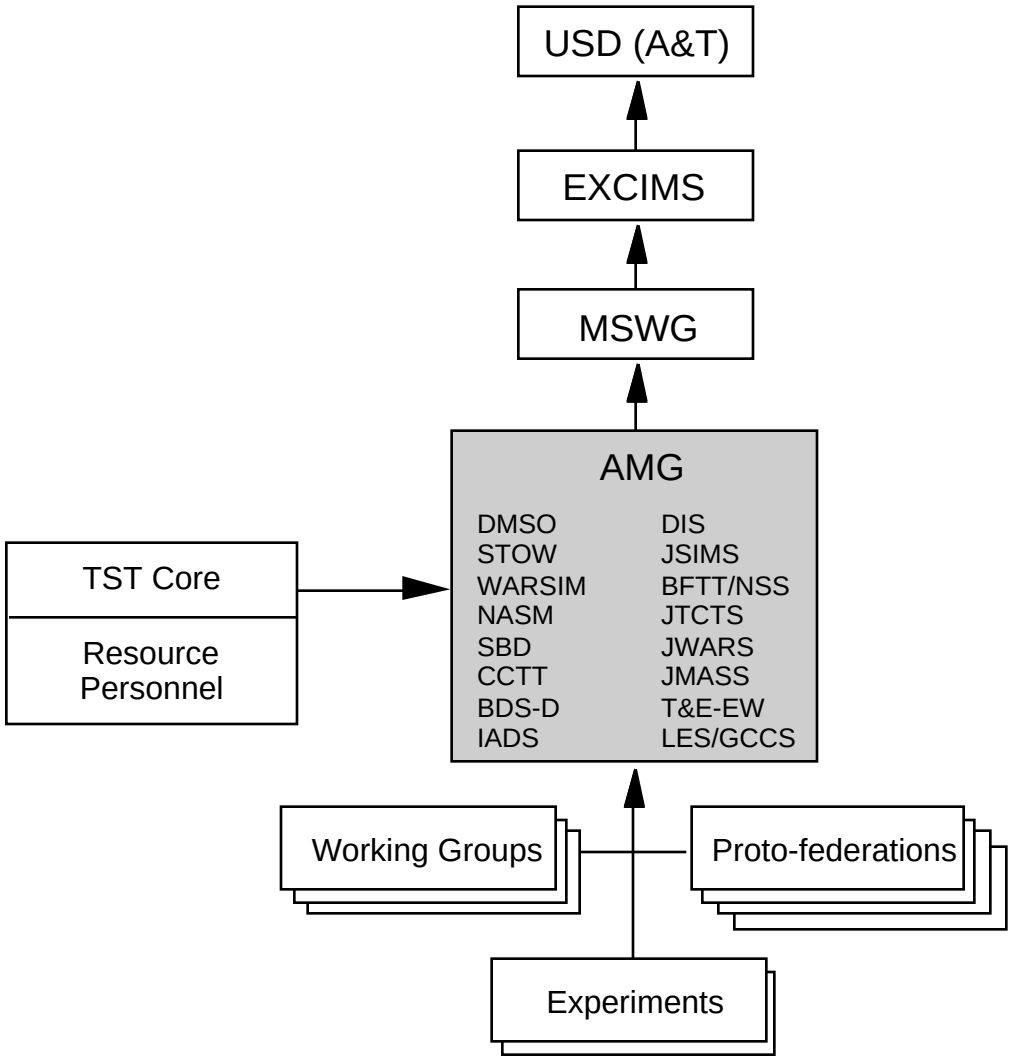
The Common Technical Framework, and specifically the High Level Architecture, represents the highest priority effort within the DoD modeling and simulation community.

High-Level Architecture Definition Process

DMSO



AMG Structure



AMG Progress to Date

DMSO

- **Technical issues have been identified and prototypes are under development to address these issues**
  - **four proto-federations**
- **AMG Working Groups established and work is underway**
  - **Interface Specification**
  - **Object Model Template**
  - **Testing**
- **Very active participation in AMG and Working Groups**
  - **AMG-11 meeting held 24-25 April 1996**
- **Technical products on schedule**
  - **v0.3 of the Object Model Template released on 23 May 1996**
  - **v0.4 of the Interface Specification released on 7 March 1996**
  - **Application Programmer's Interface (API) version 0.3 released on 1 May 1996**
  - **Version 0.32 Runtime Infrastructure released on 28 May 1996**

Key Technical Issue Areas

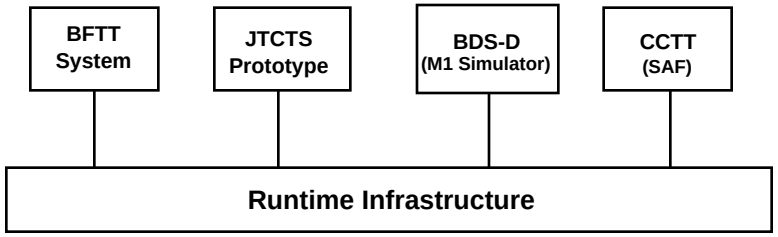
DMSO

- **Interface Specification:** ***Technical feasibility of single interface for range of simulations and support functions***
- **Runtime Infrastructure:** ***Technical feasibility, reusability, portability, and variability of RTI***
- **Simulations:** ***Impact of HLA on simulations***
- **Object Models:** ***Usability, functionality over life cycle, presentation approaches***
- **Testing:** ***Test methods for HLA and Federations***
- **Security**: ***Security Implications of the HLA***
- **Scope:** ***Breadth of HLA applicability including C4I Interfaces***

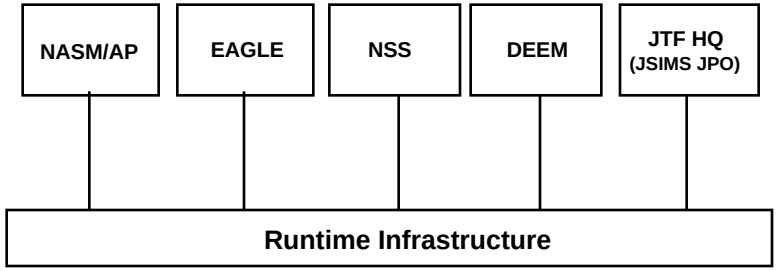
HLA Prototype Federations

DMSO

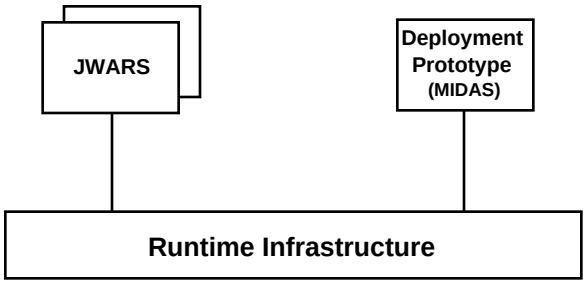
Platform Federation



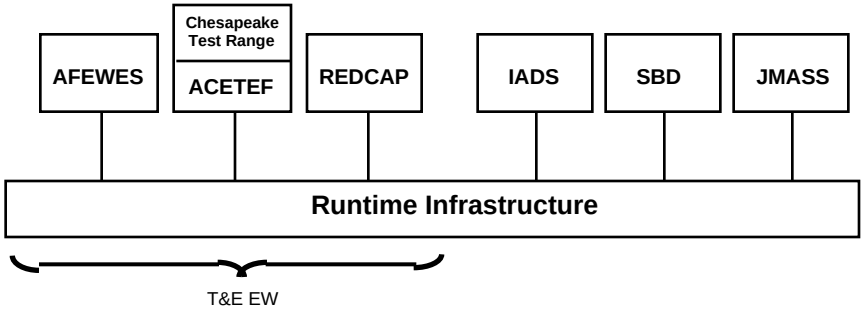
Joint Training Federation



Analysis Federation

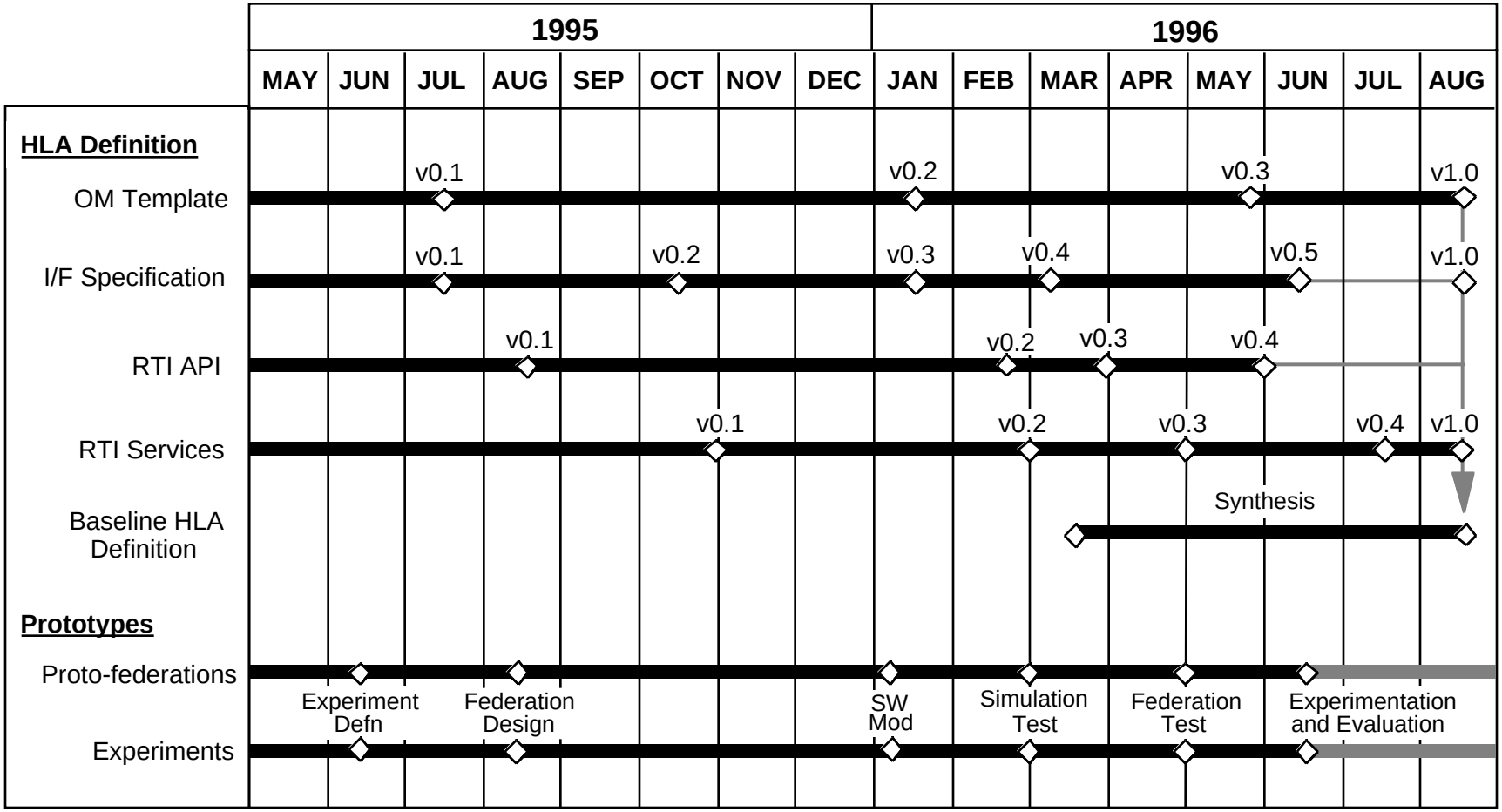


Engineering Federation



Master Schedule

DMSO



Rationale for HLA Design

DMSO

- ***Basic premises:***
  - **No single, monolithic simulation can satisfy the needs of all users**
  - **All uses of simulations and useful ways of combining them cannot be anticipated in advance**
  - **Future technological capabilities must be accommodated**
- ***Consequence:*** **Need composable approach to constructing simulation applications**
- ***Resulting design principles:***
  - **Simulation applications constructed from modular components with well-defined functionality and interfaces**
  - **Specific simulation functionality separated from general purpose supporting infrastructure**

Interoperability and Reuse

DMSO

- **HLA provides basis for establishing interoperability – within simulations, among simulations of a federation, and across functional communities**
  - **Interface definitions allow exchange of data; object models and time management constraints facilitate consistent interpretation of data**
  - **Interoperability is a matter of degree; it could require federation-specific constraints beyond those imposed by HLA**
- **HLA facilitates reuse of simulation components – for both object representations and infrastructure functionality**
  - **Interface definitions and object model allow for reuse of individual simulations and federations**
  - **Rules ensure simulations will be structured to operate under the HLA**

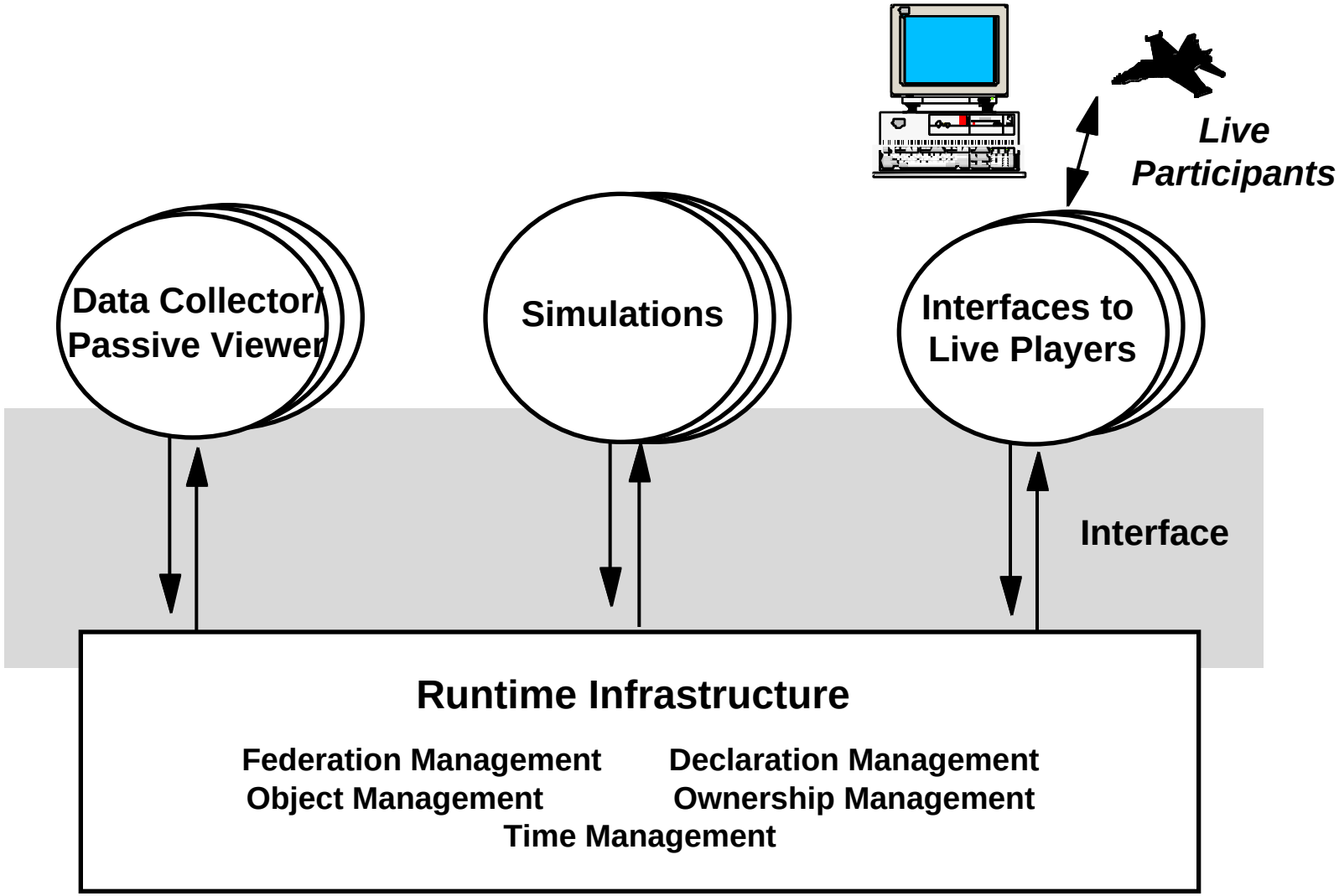
Scope of HLA

DMSO

- **Applicable to broad range of functional areas (e.g., training, contingency planning, analysis, and acquisition)**
- **Applicable to simulations involving pure software representations, man-in-the-loop simulators, and live components (instrumented-weapon and C3 systems)**
- **Related themes:**
  - **Simulations interacting as a group to support a community of common interest**
  - **Interoperability as a matter of degree; it could require federation-specific constraints beyond those imposed by HLA**

Functional View of the Architecture

DMSO



Defining the HLA

DMSO

- **HLA Rules. A set of rules which must be followed in development phase to achieve proper interaction of simulations in execution phase. These describe the responsibilities of simulations and of the runtime infrastructure in HLA federations.**
  - **Functions required of simulations to interact with other simulations**
  - **Functions required of infrastructure to support interaction of simulations**
- **Interface Specification. Definition of the interface functions between the runtime infrastructure and the simulations subject to the HLA.**
- **Object Model Template. The prescribed common method for recording the information contained in the required HLA Object Model for each federation and simulation.**

Federation Rules/Principles

DMSO

1. Federations must have an HLA Object Model (a federation object model or FOM), documented using the HLA OMT.
2. In a federation, all object representation (ownership or reflection) occurs in the Federates, not in the runtime infrastructure (RTI).
3. During a federation execution, data exchange among objects in the FOM represented (owned or reflected) in different federates occurs via the RTI.
4. During a federation execution, federates must interact with the runtime infrastructure (RTI) in accordance with the HLA interface specification.
5. During a federation execution, an attribute of an instance of an object can be owned by only one federate at any given time.

Federate Rules/Principles

DMSO

6 Federates must have an HLA Simulation Object Model (SOM) documented using the HLA OMT.

7 Federates must be able to publish/reflect any attributes of objects in their SOM and exercise SOM object interactions externally.

8 A federate must be able to either own or reflect attributes in its SOM and to transfer/accept ownership of any of these attributes dynamically during a federation execution.

9 Federates must be able to vary the conditions under which they provide updates of public attributes of objects according to their SOM.

10 Federates must be able to manage local time in a way which will allow them to coordinate data exchange in accordance with time management services.

HLA Interface

DMSO

Category	Functionality
Federation Management	Create and delete federation executions Join and resign federation executions Control checkpoint, pause, resume, restart
Declaration Management	Establish intent to publish and subscribe to object attributes and interactions
Object Management	Create and delete object instances Control attribute and interaction publication Create and delete object reflections
Ownership Management	Transfer ownership of objects/attributes
Time Management	Coordinate the advance of logical time and its relationship to real time

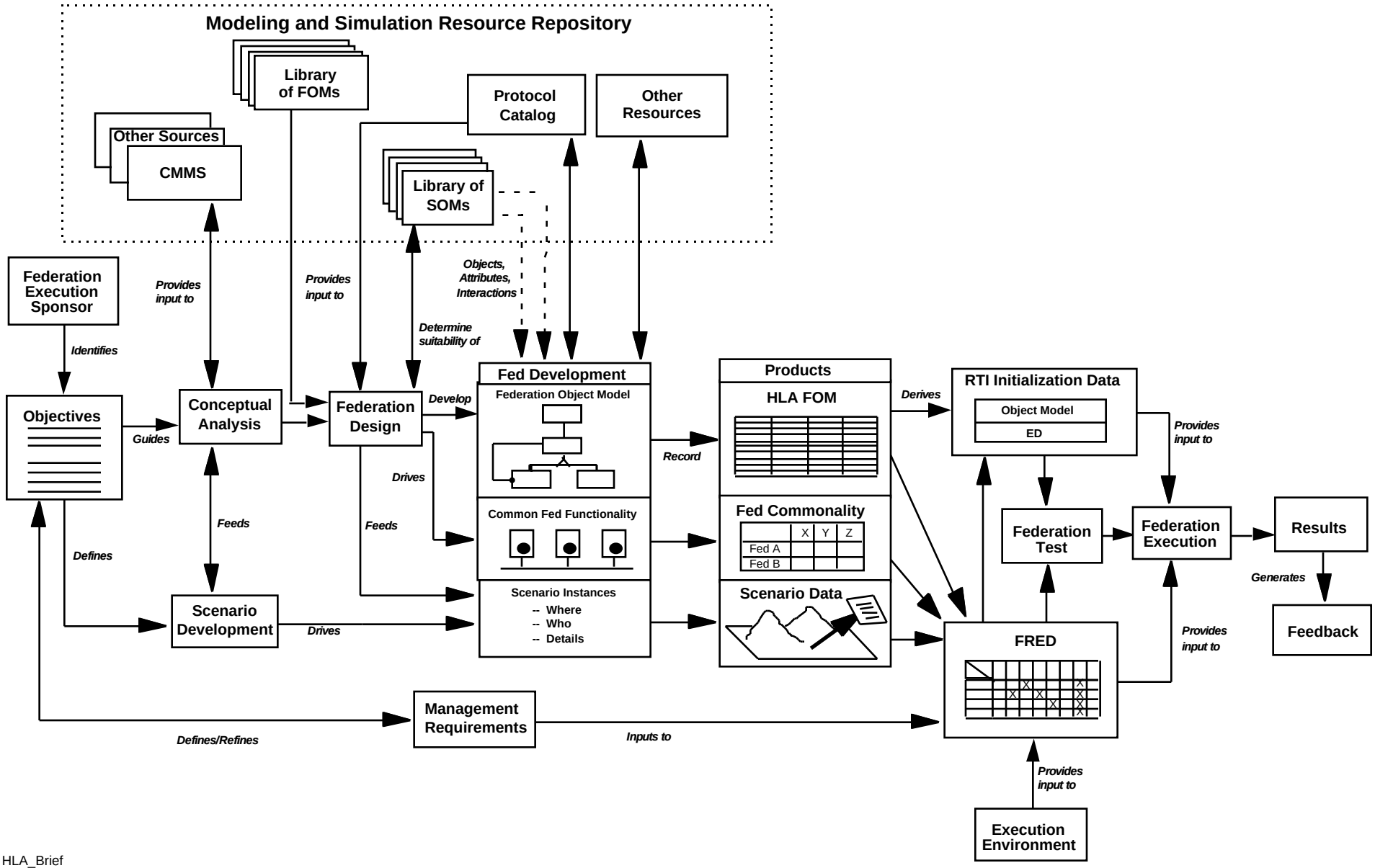
HLA Object Models and Object Model Template

DMSO

- **Federation Object Model (FOM)**
  - **Contract among "n" simulations to satisfy the objectives of a specific federation**
  - **FOM content includes a description of all shared information (objects, attributes, associations, and interactions) essential to a particular federation**
- **Simulation Object Model (SOM)**
  - **Distinct from internal simulation design information**
    - **Salient characteristics deemed pertinent to reuse**
  - **Used to determine suitability of individual simulations to achieve objectives of federations**
- **Object Model Template (OMT)**
  - **Provides a common framework for FOM documentation**
  - **Fosters interoperability and reuse of simulations and simulation components via the specification of a common representational framework**

Federation Development and Execution Process

DMSO



HLA Compliance

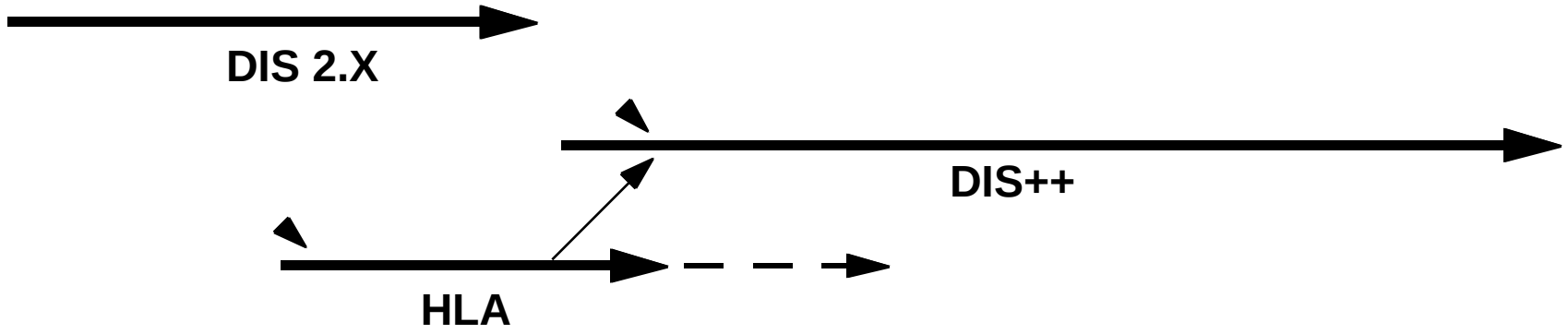
DMSO

- **AMG will define HLA compliance**
- **Testing Working Group is developing interface testing technical procedures**
- **By 2Q FY97, all on-going DoD simulation programs must be reviewed for feasibility of immediate HLA compliance**
  - **identify date for compliance; or**
  - **report to DDR&E the reasons HLA is not acceptable**
- **Goal is to lead with a carrot, not a stick**
  - **save PMs cost, schedule, risk**
  - **have readily available supporting software**
  - **facilitate interoperability and utility of their sims**

HLA Transition Plans

DMSO

- **Important that HLA be integrated into broader, industry based technical community**
  - **DIS Workshop is the desired venue for transition and evolution of the HLA. Important that DoD and DIS stay in step.**
  - **HLA appears to fit the DIS community's goals well, as reflected in the DIS Vision Document, the work of the STGPA, STG VIP, etc.**
  - **HLA implies new responsibilities for DIS Workshop**
  - **Timing looks right for next generation DIS++**



Benefits of the HLA

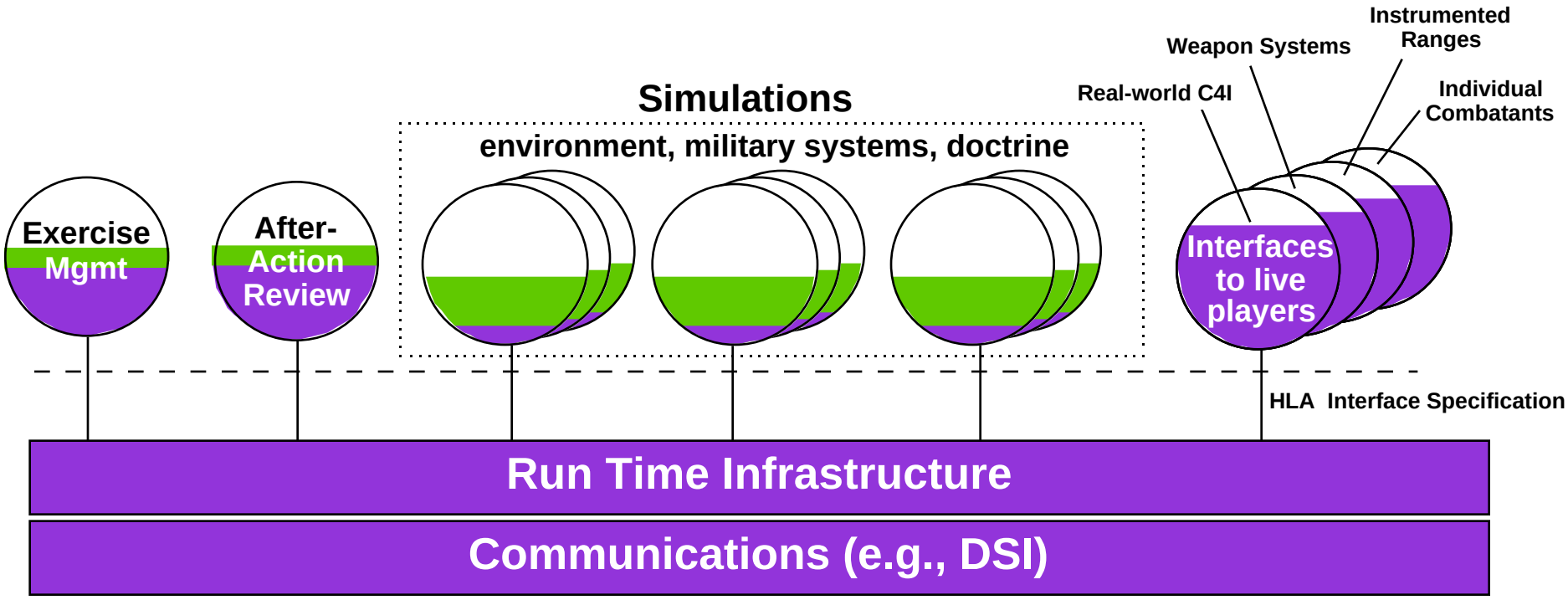
DMSO

- HLA provides a common approach to supporting
  - A broader range of DoD simulation applications
  - Larger, more complex, dynamic federations
- HLA services are key
  - *Federation Management* provides effective management tools
  - *Object Management* provides improved means for dynamic data exchange
  - *Declaration Management* allows filtering of events and objects of interest to each simulation, minimizing unnecessary message traffic
  - *Ownership Management* allows transfer of *either* objects or attributes, providing flexibility and computational efficiency
  - *Time Management* supports both real-time and logical time simulations

Greater capability, interoperability, and reuse

Opportunities for Reuse

DMSO

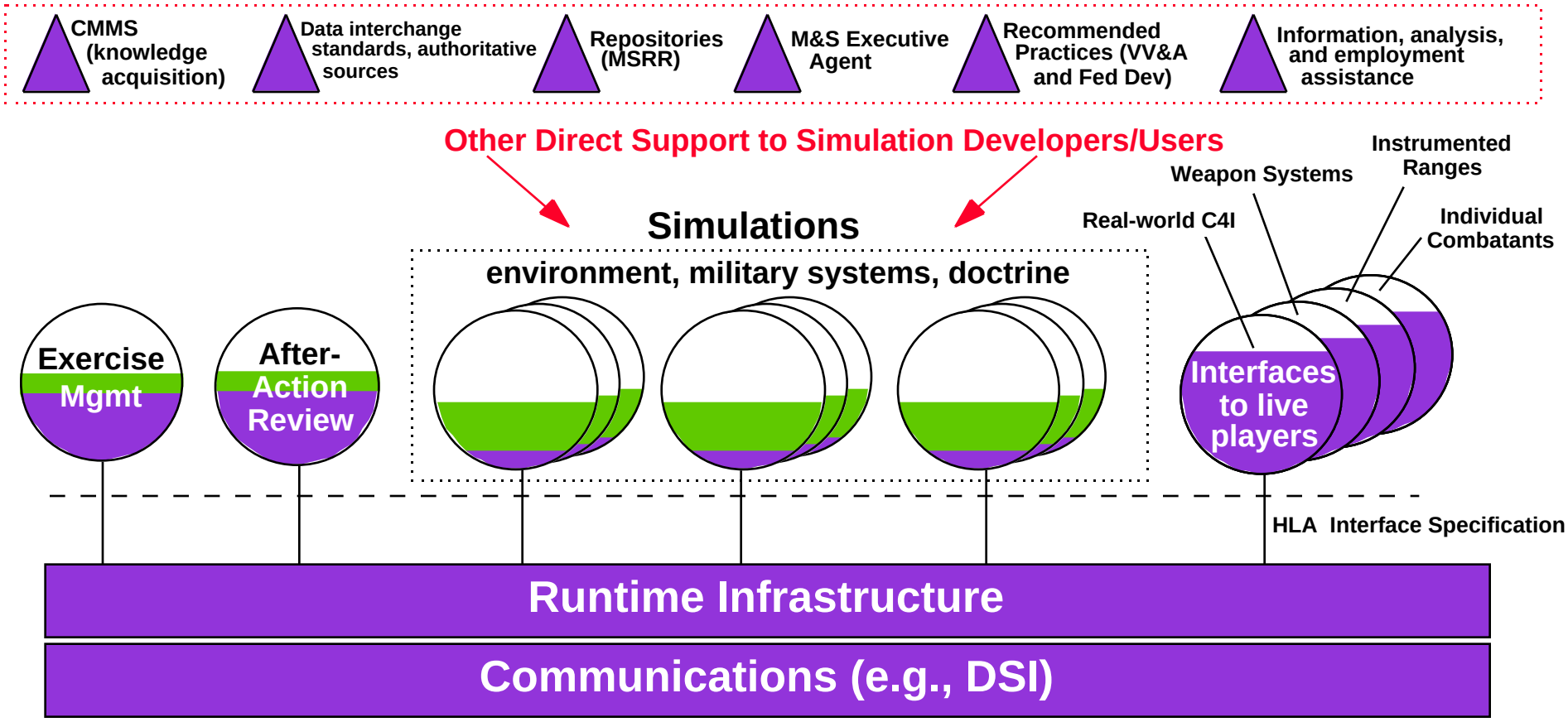


Key:

- Reusable across all DoD simulation systems
- Reusable across a simulation domain
- unique

Opportunities for Reuse (con't)

DMSO



Key:

- Reusable across all DoD simulation systems
- Reusable across a simulation domain
- unique

DMSO

Backups

How to Participate

DMSO

- **Web sites for info and HLA products**

DMSO Home Page	**http://www.dmso.mil/**
HLA Home Page	**http://www.dmso.mil/projects/hla/**

  - **HLA Management Plan**
  - **Interface Specification / API**
  - **Object Model Template**
  - **Supporting briefings**
  - **Time management scheme**
  - **Frequently Asked Questions**
- **e-mail inputs to TST**
- **Direct liaison with AMG or TST members**
- **Participate in DIS workshops**

On-Line Documentation

DMSO

- **Proceedings and products of the AMG appear under the subtopic "Common Technical Framework for M&S", under "High Level Architecture". DMSO home page site is:**

http://www.dmso.mil/

- **Users are able to view and download documents and briefings from this location.**
  - **Management Plan v1.7**
  - **Interface Specification v0.4**
  - **Object Model Template v0.3**
  - **Application Programmer's Interface v0.3**
  - **Associated briefings**

Upcoming Activities

DMSO

12-13 June 1996 — **AMG Meeting (AMG-12)**

- Technical interchange meeting. Topics include VV&A plans, data filtering experiments, new releases of the OMT and interface spec, the MSRR, and proto-federation status updates.

17-18 July 1996 — **AMG Meeting (AMG-13)**

22-23 Aug 1996 — **AMG Meeting (AMG-14)**

August 1996 — **Baseline HLA approved**

AMG Representatives

DMSO

Name	Representing
CAPT Jim Hollenbach	Defense Modeling and Simulation Office
Dr. Duncan Miller	Distributed Interactive Simulation
Dr. Randy Garrett	Synthetic Theater of War
CAPT Drew Beasley	Joint Simulation System
Ms. Annette Ratzenberger	Warrior Simulation for the Year 2000
Dr. Les Parish	Battle Force Tactical Trainer/ Naval Simulation System
Mr. Timothy Rudolph	National Air and Space [Warfare] Model
Mr. Al Gramp	Joint Tactical Combat Training System
Mr. Gary Jones	Simulation Based Design
COL James Shiflett	Close Combat Tactical Trainer
Dr. Jim Metzger	Joint Warfare System
Dr. Jerry Arnett	Joint Modeling and Simulation System
Mr. Rich Pace	Test & Evaluation/Electronic Warfare
Mr. Maynard Schmale	Integrated Air Defense Simulation
Mr. Andy Rumbaugh	Leading Edge Services/Global Command and Control System
COL Jim Etchechury	Battlefield Distributed Simulation-Developmental

AMG Technical Support Team (Core)

DMSO

Name	Organization
Dr. Judith Dahmann	DMSO (Director)
Dr. Donald Ponikvar	DMSO (Chief of Staff)
LTC Peter Polk	DMSO
Dr. Jack Kramer	IDA (I/F WG)
Mr. Dell Lunceford	ARPA
Dr. Rich Ivanetich	IDA
Dr. Duncan Miller	AMG
Dr. Richard Weatherly	MITRE
Mr. Jim Calvin	MIT/Lincoln Lab
Mr. Bob Lutz	JHU APL (OMTWG)
Ms. Margaret Loper	GTRI (TWG)
Mr. Steve Seidensticker	DMSO